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**NOTES ON ACCESSORIES FOR
FREE DIVERS
PARTS I AND II**

by

**James H. Carpenter
Thomas C. Hopkins Jr.
and
Richard C. Whaley**

**Reference 54-3
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NOTES ON ACCESSORIES FOR FREE DIVERS

I. THE CONSTRUCTION OF A HOOD FOR PROTECTION IN COLD WATER

by

James H. Carpenter and Thomas C. Hopkins, Jr.

II. A PACK BOARD HARNESS FOR THE AQUA-LUNG

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out for: the Office of Naval Research of the
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I. THE CONSTRUCTION OF A HOOD FOR PROTECTION IN COLD WATER

by

James H. Carpenter
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The use of underwater swimming gear in cold water makes protective clothing a necessity. Owen (1953) comments: "...the adverse effects of such activity deserve the utmost consideration from the efficiency and safety viewpoints." The "Report of the Cooperative Underwater Swimmer Project" (Revelle, R. et al. 1952) includes data and discussion of protective clothing for use in water of 50°F. This report indicates that a "wet" suit made of 1/8 inch foam rubber is comparable to a "dry" suit which remains dry and is superior to a leaky "dry" suit which is the usual kind. It is suggested that a "wet" suit made of 1/4 inch thick unicellular foam rubber would be suitable for protection at 32°F.

The authors have found that for moderate activity in water of 35°F to 40°F during periods ranging up to 30 minutes satisfactory protection for the body is afforded by two different suits. Protection was judged "satisfactory" if in the opinion of the diver chilling and physical discomfort was no greater than that ordinarily experienced in 65°F water for the same period of time with no protection. The "Seal" suit, a "dry" suit, obtained from U. S. Divers Company, Los Angeles, California, was found to remain nearly dry with only slight leakage around the flutter valve. This suit with two pairs of long underwear and a towel around the neck was adequate. The "Sub-Mariner," secured from the Engineering and Development Company, Berkeley, California, is a

"wet" type, 1/8 inch foam neoprene, suit. It was worn under a "Firelli" type two piece "dry" suit, which decreased circulation through the foam suit. This combination resulted in excellent protection from the cold. It is anticipated that foam rubber underwear with the "Seal" suit will be equally good.

The protection afforded the head and, in particular, the face by these suits is not sufficient for comfort. The thin gum rubber of the "Seal" suit does not protect the frontal sinuses and the lower face is completely exposed. The foam rubber hood of the "Sub-Mariner" leaves similar exposed areas but can be pulled down over the top of the face mask, covering the forehead except at the sides in the region of the temples (Figure I-1). In cold water, if the hood slips back, sharp pains promptly inform the swimmer of the loss of protection. To remedy these defects the authors designed and made a "wet" hood which provides nearly complete protection.

One quarter inch thick unicellular neoprene bonded on both sides, obtained from the Fotomac Rubber Company, Washington, D. C., was used and the seams were joined with B. F. Goodrich Industrial Adhesive A232B and reinforced with strips of one thirty-second inch sheet neoprene.

The use of heavy neoprene requires that the hood be tailored to the individual since the lack of elasticity causes discomfort in regions of poor fit. The tailoring may be accomplished in four steps. The first step is the construction of the back seam. Cut two pieces using Figure I-4 as a pattern. The pattern shown should fit individuals of medium size (size 15 neck). Curve ABC should be cut with care, since it will not be altered. Cut a strip of the

sheet neoprene one and one half inches wide and twenty-five inches long. Butt the two pieces of foam rubber at A and fasten them temporarily with scotch tape. Butt and fasten with scotch tape several inches from A toward B. Turn the material over and apply adhesive to the joint and one inch on each side. Apply adhesive to the strip for the length fastened allowing about an inch at the end to be folded under after the scotch tape is removed. Allow the adhesive to become tacky and press strip in place with one inch overhang. Continue in this manner along the curve ABC to point C. Place the hood on the diver's head and inspect for fit. The point C should be at the bridge of the nose when the concave contour between AB is snug against the back of the head. The second step is the fitting and joining of the material in the chin area. In the region DE a compromise between snugness around the neck and ease of putting the hood over the head is necessary. The contour shown in figure I-4 should result in snugness two inches above E and fairly loose fit below and above this region. Trim parallel to the original cut until a comfortable fit is found. Cut a sheet neoprene strip one and one half inches wide and nine inches long. Position the seam with scotch tape on the inner side of the hood and cement from E to D as above, working a short distance at a time. The third step is the adjustment of the hood to the face mask. With the hood on the diver's head and with his face mask in position trim along CD until the mask seats properly against the diver's face. A "Squale" type mask which has its strap attached to the glass holder is suitable for use with this hood. The last step in the tailoring is the fit of the hood in the cheek and lip areas. Cut a piece of foam neoprene as shown in figure I-5.

This piece is to be placed along the lower portion of the face mask and covers the space above the lips. It should be attached so that the material covering the cheeks is pulled in to a comfortable fit. Cement or scotch tape one side and mark the proper position of the other side while the hood is on the diver. Cement in place. With the hood and mask on the diver insert the aqua-lung mouthpiece and tee. Trim the surplus foam neoprene until a loose fit is obtained. A fit that is too tight causes the hood to pull on the mouthpiece and a fit that is too loose allows too rapid circulation of water through the hood.

The expulsion of air through the nose to equalize pressure in the mask and ears during descents fills the hood with air causing an undesirable buoyancy and pull on the chin.

A satisfactory relief valve may be made as follows. Trim or machine a one inch cube of a suitable material (lucite, hard rubber, wood, or metal) to a three-quarter inch diameter cylinder leaving a one-eighth inch shoulder at one end. Drill a one half inch diameter hole through the block. Insert the cylindrical portion in an Aqua-Lung exhaust valve. Cut a five-eighth inch diameter hole in the hood at B with a number 10 cork borer or similar tool. Insert the valve assembly and cement it in place.

Figures I-2, I-3, and I-6 show the finished hood.

References

- Owen, D. M. (1953): A manual for free divers. Woods Hole Oceanographic Institution. Reference No. 53-94.
- Revelle, R. et al. (1952): Report of the cooperative underwater swimmer project. Office of Naval Research, Washington, D. C.



Figure I-1

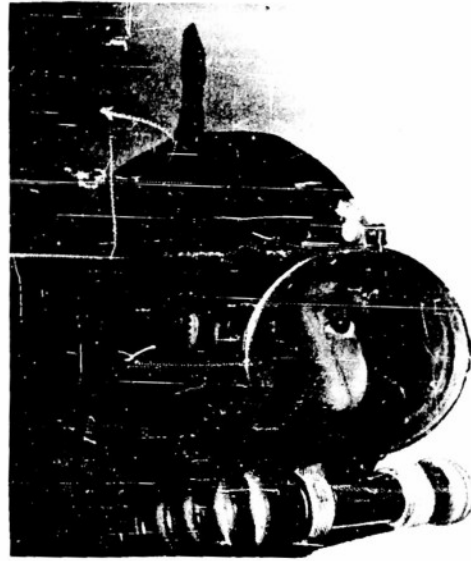
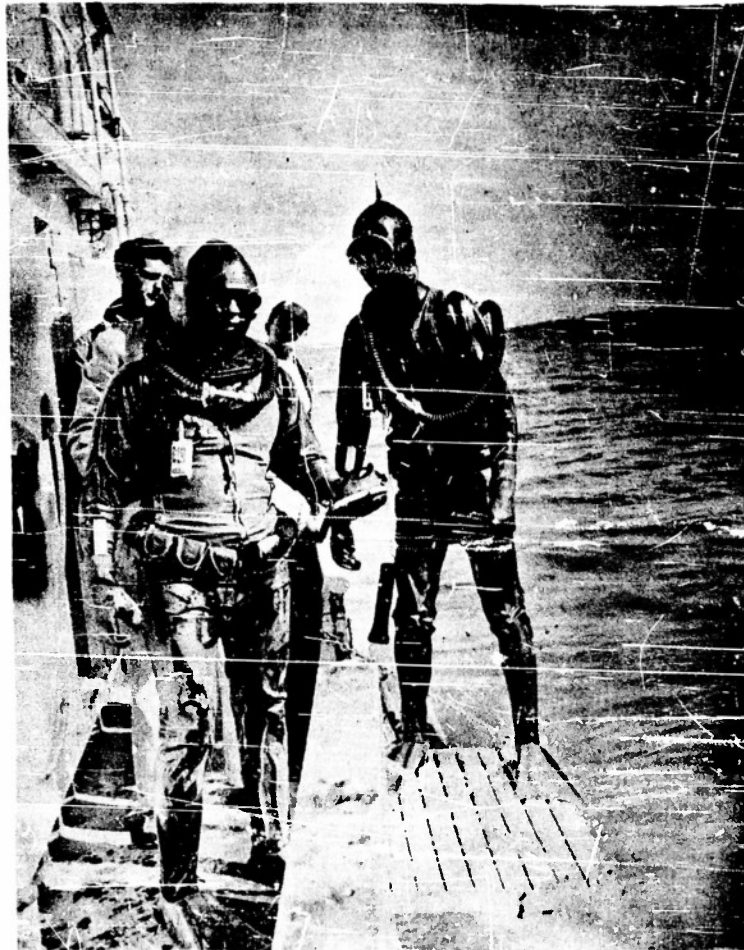


Figure I-2

Figure I-3



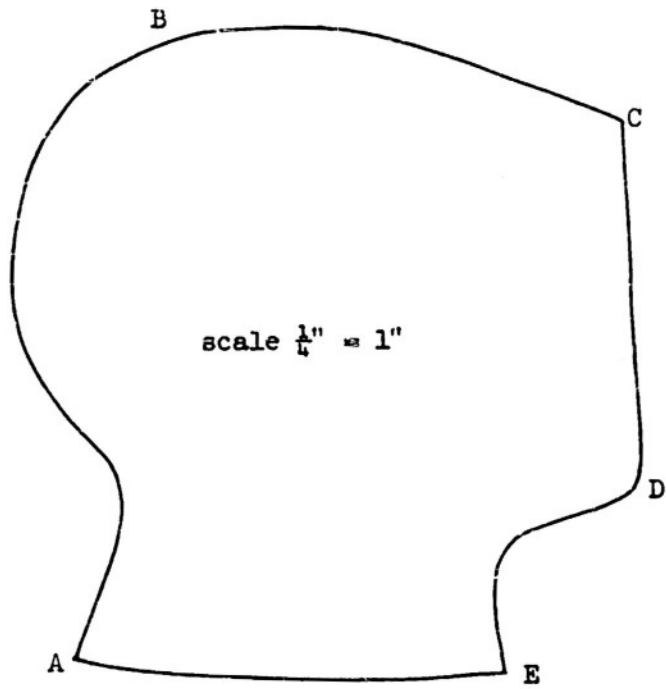


Figure I-4



Figure I-5

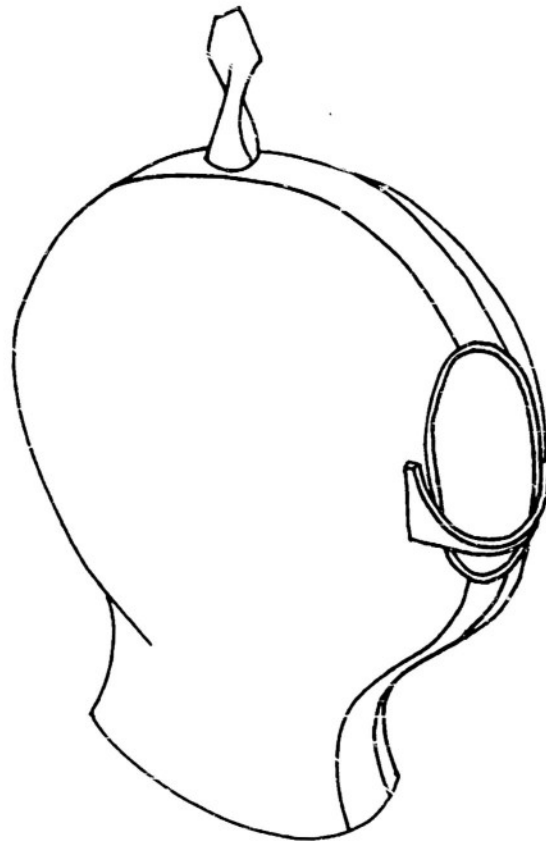


Figure I-6

II. A PACK BOARD HARNESS FOR THE AQUA-LUNG

by

James H. Carpenter
and
Richard C. Whaley

For the comfort of an Aqua-Lung diver it is necessary that the compressed air tank be properly positioned on his back and have only a very limited free movement. The two kinds of harnesses, webbing and vest, at present on the market do not adequately satisfy these requirements. The Scott Aviation Corporation, Lancaster, N. Y. has designed a pack board harness for their diving gear, the Hydro-Pak, that satisfies both to a high degree. Unfortunately the 50 cubic foot tanks used with the Hydro-Pak are smaller than the 70 cubic foot tanks used with the Aqua-Lung so that the Scott pack board harness can not be used with the Aqua-Lung.

This note presents the modifications necessary to adapt the Scott design to the Aqua-Lung. Materials for construction of the pack board harness were secured from a surplus dealer at a cost of about ten dollars. Figures II-1, II-2, II-3, and II-4 show the appearance and construction of the harness. In order that the clamp shall take an even strain on the tank, it was found advisable to attach the eccentric handle to the clamp strap first and with a compressed air tank in position, locate the correct point of attachment to the board or back plate. Wide straps are conducive to the comfort of the diver. We have found two inch canvas webbing very

satisfactory. It is important that the belt buckle be of a type that sets the belt up tight in closing rather than slacking it off. It should also have an easy release for emergencies. We have found the turret-gun safety belt, which is available from surplus, meets both these requirements.

Figure II-1

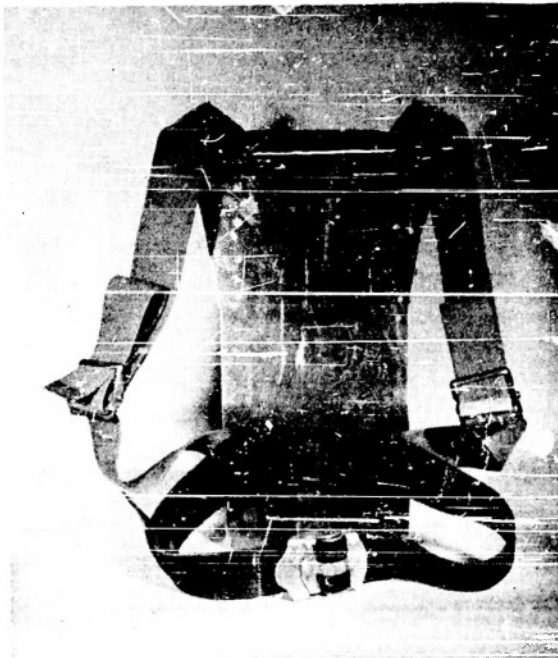


Figure II-2

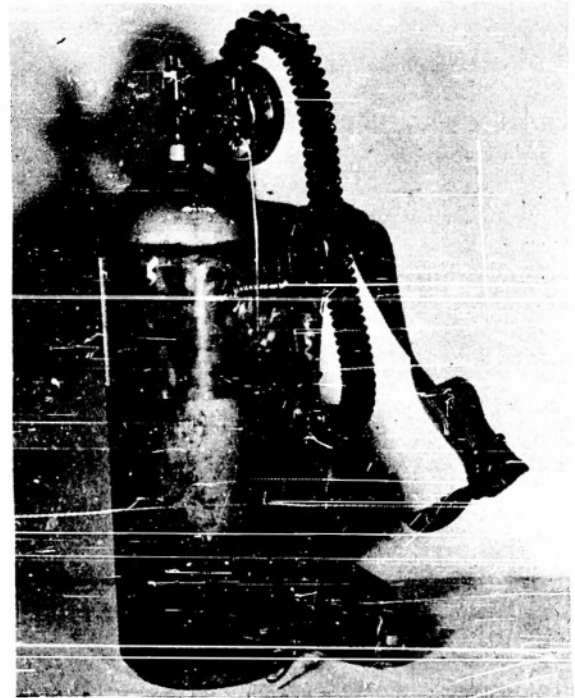
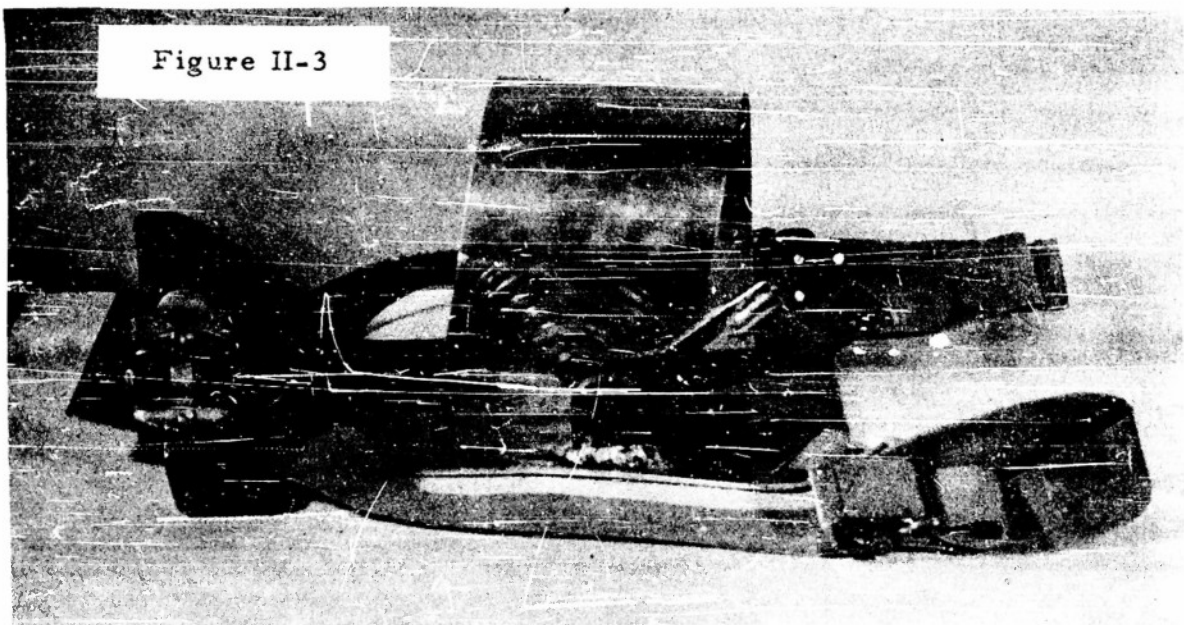


Figure II-3



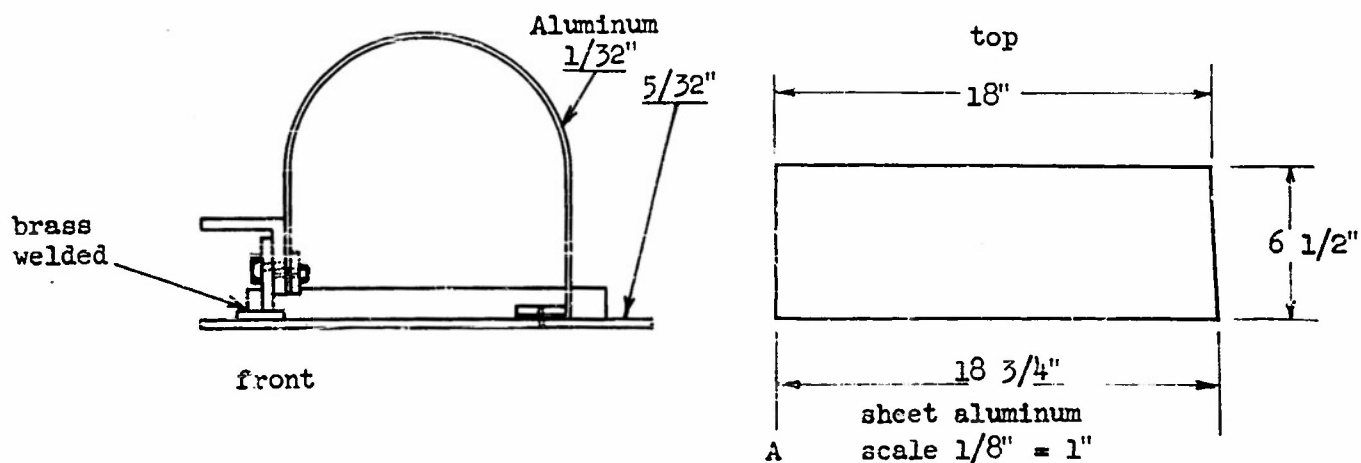
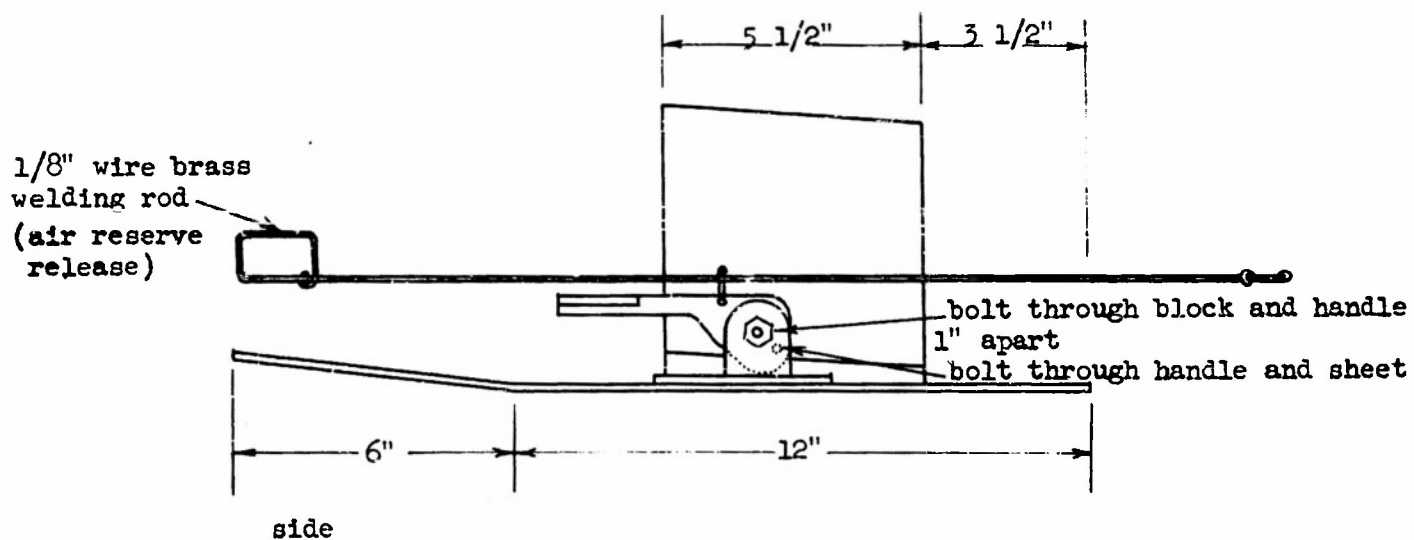
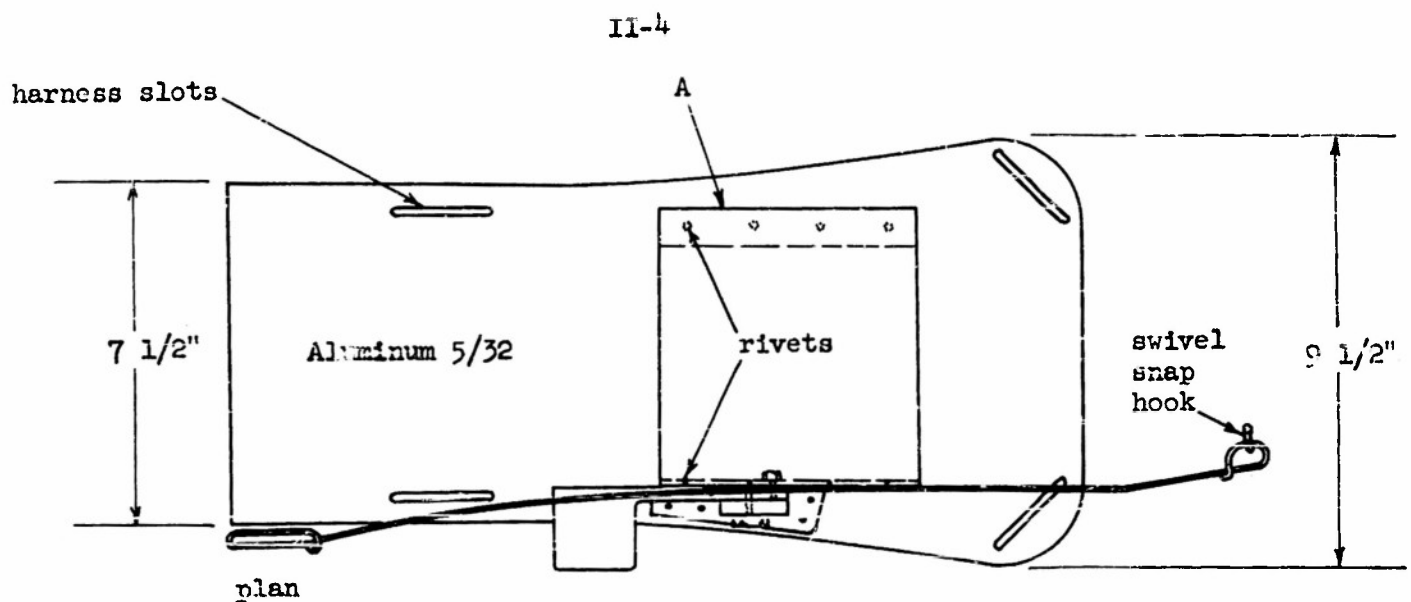


Figure II-4 Plan of back board. scale 1/4" = 1"

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